THE ROLE OF HIGHER TWIST IN DETERMINING POLARIZED PARTON DENSITIES FROM DIS DATA*

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Different methods to extract the polarized parton densities from the world polarized DIS data are considered. The higher twist corrections $h^N(x)/Q^2$ to the spin dependent proton and neutron g_1 structure functions are found to be non-negligible and important in the QCD analysis of the present experimental data. Their role in determining the polarized parton densities in the framework of the different approaches is discussed.

One of the features of the polarized DIS is that a lot of the present data are at low Q^2 ($Q^2 \sim 1-5\ GeV^2$). For that reason, to confront correctly the QCD predictions to the experimental data and to determine the polarized parton densities a special attention should be paid to the non-perturbative higher twist (powers in $1/Q^2$) corrections to the nucleon structure functions. The size of higher twist corrections (HT) to the spin structure function g_1 and their role in determining the polarized parton densities in the nucleon using different approaches of QCD fits to the data are discussed in this talk.

Up to now, two approaches have been mainly used to extract the polarized parton densities (PPD) from the world polarized DIS data. According

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to the first [1,2] the leading twist LO/NLO QCD expressions for the structure functions g_1^N and F_1^N have been used in order to confront the data on spin asymmetry $A_1(\approx g_1/F_1)$ and g_1/F_1. We have shown [3,4] that in this case the extracted from the world data "effective" HT corrections $h^{g_1/F_1}(x)$ to the ratio g_1/F_1

$$\frac{g_1(x,Q^2)}{F_1(x,Q^2)} = \frac{g_1(x,Q^2)_{\rm LT}}{F_1(x,Q^2)_{\rm LT}} + \frac{h^{g_1/F_1}(x)}{Q^2} \tag{1}$$

are negligible and consistent with zero within the errors, *i.e.* $h^{g_1/F_1}(x) \approx 0$. (Note that in QCD: $g_1 = (g_1)_{LT} + (g_1)_{HT}$; $F_1 = (F_1)_{LT} + (F_1)_{HT}$.) What follows from this result is that the higher twist corrections to g_1 and F_1 compensate each other in the ratio g_1/F_1 and the PPD extracted this way are less sensitive to higher twist effects.

According to the second approach [6,7], g_1/F_1 and A_1 data have been fitted using phenomenological parametrizations of the experimental data for the unpolarized structure function $F_2(x,Q^2)$ and the ratio $R(x,Q^2)$ of F_2 and F_1 (F_1 has been replaced by the usually extracted from unpolarized DIS experiments F_2 and R). Note that such a procedure is equivalent to a fit to $(g_1)_{exp}$, but it is more precise than the fit to the g_1 data themselves actually presented by the experimental groups because the g_1 data are extracted in the same way for all of the data sets.

If the second approach is applied to the data, the "effective higher twist" contribution $h^{g_1/F_1}(x)/Q^2$ to $A_1(g_1/F_1)$ is found [1] to be sizeable and important in the fit [the HT corrections to g_1 cannot be compensated because the HT corrections to $F_1(F_2$ and $R)$ are absorbed by the phenomenological parametrizations of the data on F_2 and R]. Therefore, to extract correctly the polarized parton densities from the g_1 data, the HT corrections to g_1 have to be taken into account. Note that a QCD fit to the data in this case, keeping in $g_1(x,Q^2)_{QCD}$ only the leading-twist expression (as it was done in [6,7]), leads to some "effective" parton densities which involve in themselves the HT effects and therefore, are not quite correct.

Keeping in mind the discussion above we have analyzed the world data on inclusive polarized DIS [5] taking into account the higher twist corrections to the nucleon structure function $g_1^N(x,Q^2)$. In our fit to the data we have used the following expressions for g_1/F_1 and A_1:

$$\left[\frac{g_1^N(x,Q^2)}{F_1^N(x,Q^2)}\right]_{exp} \Leftrightarrow \frac{g_1^N(x,Q^2)_{\rm LT} + h^N(x)/Q^2}{F_2^N(x,Q^2)_{exp}} 2x \frac{[1+R(x,Q^2)_{exp}]}{(1+\gamma^2)} ,$$

$$A_1^N(x,Q^2)_{exp} \Leftrightarrow \frac{g_1^N(x,Q^2)_{\rm LT} + h^N(x)/Q^2}{F_2^N(x,Q^2)_{exp}} 2x[1+R(x,Q^2)_{exp}] , \tag{2}$$

where $g_1^N(x, Q^2)_{\rm LT}$ is given by the leading twist QCD expression including the target mass corrections (N=p, n, d). The dynamical HT corrections $h^N(x)$ in (2) are included and extracted in a *model independent way*. In our analysis their Q^2 dependence is neglected. It is small and the accuracy of the present data does not allow to determine it. The details of our analysis are given in [8]. Unlike the paper [8], the polarized PD determined in this analysis are compatible with the positivity bounds imposed by the MRST'02 unpolarized PD instead of the MRST'99 ones. The dependence of the polarized PD on the positivity constraints imposed will be discussed in detail in a forthcoming paper.

We have found that the fit to the data is significantly improved when the higher twist corrections to g_1 are included in the analysis, especially in the LO QCD case. The best LO and NLO($\overline{\rm MS}$ scheme) fits correspond to $\chi^2_{\rm DF,LO} = 0.91$ and to $\chi^2_{\rm DF,NLO} = 0.89$, while in the case of LO and NLO($\overline{\rm MS}$) fits when HT are not included, $\chi^2_{\rm DF,LO} = 1.41$ and $\chi^2_{\rm DF,NLO} = 1.19$, respectively.

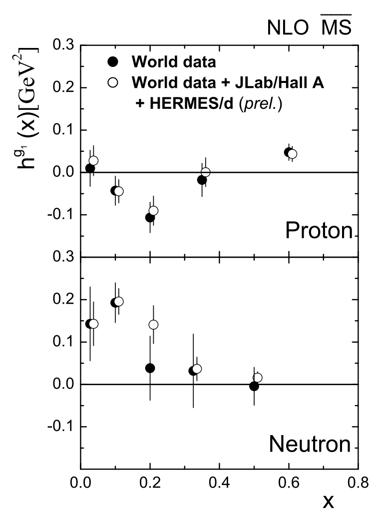

Figure 1. Higher twist corrections to the proton and neutron g_1 structure functions extracted from the data on g_1 in the NLO QCD approximation for $g_1(x, Q^2)_{\rm LT}$.

We have also found that the size of the HT corrections to g_1 is *not* negligible and their shape depends on the target (see Fig. 1). In Fig. 1 our

results on the HT corrections to g_1 (open circles) including in the world data set the recent JLab/Hall A [9] and preliminary HERMES [10] data are also presented. As seen from Fig. 1, the higher twist corrections to the neutron spin structure functions in the large x region are much better determined now. It was also shown that the NLO QCD polarized PD($g_1^{\rm LT}+{\rm HT}$) determined from the data on g_1, including higher twist effects, are in good agreement with the polarized PD($g_1^{\rm NLO}/F_1^{\rm NLO}$) found from our analysis of the data on g_1/F_1 and A_1 using for the structure functions g_1 and F_1 only their *leading* twist expressions in NLO QCD. This observation confirms once more that the higher twist corrections $h^{g_1/F_1}(x)$ to g_1/F_1 and A_1 are negligible, so that in the analysis of g_1/F_1 and A_1 data it is enough to account only for the leading twist of the structure functions g_1 and F_1.

In conclusion, we have found that in order to confront the QCD predictions for the nucleon spin structure function g_1 to the present experimental data on g_1 and to extract correctly the polarized parton densities from these data, the higher twist corrections to g_1 have to be taken into account in the analysis. While, in the fit to g_1/F_1 and $A_1(\approx g_1/F_1)$ data it is enough to account only for the leading twist contributions to the structure functions g_1 and F_1 because the higher twists corrections to g_1 and F_1 compensate each other in the ratio g_1/F_1. Further investigations on the role of higher twist effects in semi-inclusive DIS processes would be important for the correct determination and flavor separation of the valence and light sea quark parton densities.

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